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SHORT COMMUNICATION

Significance of Environmental Genomics Research

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SUMMARY

Environmental Genomics serves as a guide for an environmental scientist who wishes to squeeze genomics to solve environmental problems. Environmental genomics try to find out the approach of an organism or group of organisms to the changes in their external environment at the genetic level [1]. Since the genome responses are diverse, environmental genomics has the necessity to integrate molecular biology, physiology, toxicology, ecology, systems biology, epidemiology and population genetics into an interdisciplinary research program [2].

The goal of the newly emerging discipline of environmental genomics is to bridge the current gap between genetic studies in the laboratory and interactions of organisms in their natural location. It is to understand basic cellular and developmental processes; systems level analyses of genetic adaptations [3]. These fields of exploration are trying to connect the glaring gap flanked by genetic processes in individual organisms of a single species and their ecological processes. This will direct the interaction of many individuals drawn from the entire species inventory of an ecosystem [4]. One reason for this gap was inaccessible model species in evolutionary and ecological research. This has typically suffered owing to the lack or diminutive genetic tools. If at all anything is known, very little is known in the arena of well established genetic models and their ecosystems [5].

Genomic tools have also been increasingly exploited to understand the interaction between different organisms, particularly between pathogens and their hosts [6]. In view of the requirement of high technological investments, genetic and genomic approaches have traditionally applied only to a small set of carefully chosen model species. The species which are usually analyzed in the laboratory environment especially the nematode worms, fruit flies and *Arabidopsis sp.* have typically adapted to laboratory conditions. They were genetically inbred to maintain in lab conditions. So it is difficult to adapt these species outside the laboratory in their natural environment [7].

Inspite of its limitations like the cost effective tools, technological resources and the inability of carrying these organisms from the lab to outer environment; still there are new approaches to address the genetics of adaptations and ecological interactions in natural populations. It is easy to develop genetic approaches for ecological model systems due to advanced technology and globalization [8]. Due to recent technological inventions, it can be distinguished into non mutants and laboratory induced mutant phenotypes. These mutant phenotypes can be used in nature to get the adaptive traits which are normally continuous reflecting the effect of several loci on the genotype. Regardless of their genetically more complex architecture, such phenotypes can be studied by forward genetic techniques such as Quantitative Trait Locus (QTL) analysis of experimental populations [11]. An

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alternative genome wide association method is also used for phenotypic and genotypic information for natural populations [9].

Gordon Conference on Evolutionary & Ecological Functional Genomics was held in 2009, which covered many aspects of this emerging field (Environmental Genomics). A special funding program on 'Ecological and Evolutionary functional genomics' coordinated by the European Science Foundation (ESF) was established in 2009 and started funding in 2010 [4]. Next generation sequencing technologies accomplished recently fetched ecology to the molecular level. The results of next generation sequencing appropriate to ecology got published in the leading journal 'Next generation molecular ecology' in 2010. A selected number of research centres are exploiting the current sequencing revolution for evolutionary and ecological studies. Few of them are NIH (National Institute of Health) funded Stanford Genome Evolution Center; NSF (National Science Foundation) funded National Evolutionary Synthesis Centre (NESCent) and Genome Institute (JGI). These organizations turn its community sequencing program into individual organisms of ecological relevance [9].

The research preference in ecological genomics has been considerably increased with the massive development of DNA sequencing power and genomic approaches in recent times. Parallel growth of imaging and remote sensing technologies allows the monitoring of natural populations [8]. It will be feasible to perform comparative sequencing of thousands of individual genomes from a species and to achieve genome scale insights of natural variation in the near future. So it is not only possible to produce variegated populations that are created in the laboratory by crossing but also alter the natural populations that have been phenotyped in the wild. Thus ecological and evolutionary model species that have not previously tractable for genetic analysis can now be included in molecular approaches. Similarly, complex communities of microorganisms can be efficiently sequenced to gain our new benefits [5].

Simple genomic data do not provide much biological meaning. The obvious challenge will be to find a balance between the awesome power of data generation technologies and the depth of scientific truth. This can be achieved only through close collaboration between biologists, engineers and informaticians [10]. So the biological concepts of comparative analysis and experimental strategies for functional analysis have to be developed to exploit the advances in data collection [9]. The investigator first gathers taxonomic knowledge, species inventories and biodiversity assessments. This should be strengthened by sequence based approaches (DNA barcoding and DNA sequencing) as well as by remote sensing technology. Subsequently a solid understanding of dynamics in interaction and their realistic analysis will be needed [11,12].

The function of genes has studied in a very limited number of individual organisms and species. An absolute understanding of the ecosystem will be possible by understanding the genetics of adaptations and community interactions. [11]. If we adapt these improvements in exploration, the modern genetics will surely move forwards mainly from a biomedical perspective to an ecological perception. Correlated to the global change, massive shift of inventories in gene function analysis towards the ecological and evolutionary standpoint should be carried out to improve the environmental genomics and its benefits.

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